

Claims

1. A nitride semiconductor light emitting device comprising:

- 5 an n-type nitride semiconductor layer;
 an In-containing super lattice structure layer formed above the n-type nitride semiconductor layer;
 a first electrode contact layer formed above the super lattice structure layer;
10 a first cluster layer formed above the first electrode contact layer;
 a first In-containing nitride gallium layer formed above the first cluster layer;
 a second cluster layer formed above the first In-containing nitride gallium layer;
15 an active layer formed above the second cluster layer;
 a p-type nitride semiconductor layer formed above the active layer; and
 a second electrode contact layer formed above the p-type nitride semiconductor layer.
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2. The device according to claim 1, wherein the active layer comprises:

- 25 a first quantum well layer having an $\text{In}_y\text{Ga}_{1-y}\text{N}$ well layer/ $\text{In}_z\text{Ga}_{1-z}\text{N}$ barrier layer structure;
 a second In-containing nitride gallium layer formed above the first quantum well layer; and
 a second quantum well layer formed above the second In-containing nitride gallium layer to have an $\text{In}_y\text{Ga}_{1-y}\text{N}$ well layer/ $\text{In}_z\text{Ga}_{1-z}\text{N}$ barrier layer structure.
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3. The device according to claim 1, further comprising a buffer layer formed down the n-type nitride semiconductor layer, and a substrate formed down the buffer layer.

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4. The device according to claim 1, wherein the n-type

nitride semiconductor layer is doped with indium (In).

5 5. The device according to claim 3, wherein the buffer layer has one selected from an AlInN structure, an AlInN/GaN layered structure, an InGaN/GaN super lattice structure, an In_xGa_{1-x}N/GaN layered structure, and an Al_xIn_yGa_{1-x-y}N/In₂Ga_{1-z}N/GaN layered structure.

10 6. The device according to claim 1, wherein the first electrode contact layer is a Si-In co-doped nitride gallium layer.

15 7. The device according to claim 1, wherein the first cluster layer and/or the second cluster layer are formed to have a thickness of atomic scale.

 8. The device according to claim 1, wherein the cluster layers are formed of SiN_a.

20 9. The device according to claim 1, wherein the first In-containing nitride gallium layer has a surface shape grown in a spiral mode.

25 10. The device according to claim 1, wherein the first In-containing nitride gallium layer has a surface shape grown and connected up to a surface of the active layer.

30 11. The device according to claim 1, wherein the active layer has a single quantum well structure or a multi quantum well structure, which is has an In_xGa_{1-x}N well layer/In_yGa_{1-y}N barrier layer.

35 12. The device according to claim 11, wherein the In_xGa_{1-x}N well layer/In_yGa_{1-y}N barrier layer have indium contents of 0<x<0.35 and 0<y<0.1, respectively.

13. The device according to claim 1, wherein the first In-containing nitride gallium layer is expressed as $\text{In}_x\text{Ga}_{1-x}\text{N}$, and has a value of $1 < x < 0.1$.

5 14. The device according to claim 11, further comprising a SiN_x cluster layer formed between the $\text{In}_x\text{Ga}_{1-x}\text{N}$ well layer and the $\text{In}_y\text{Ga}_{1-y}\text{N}$ barrier layer of the active layer to have a thickness of atomic scale.

10 15. The device according to claim 1, further comprising a SiN_x cluster layer formed between the active layer and the p-nitride semiconductor layer to have a thickness of atomic scale.

15 16. The device according to claim 1, wherein the second electrode contact layer is formed to have one selected from an $\text{In}_x\text{Ga}_{1-x}\text{N}/\text{In}_y\text{Ga}_{1-y}\text{N}$ super lattice structure, an $\text{In}_x\text{Ga}_{1-x}\text{N}$ super grading structure and $(\text{In}_x\text{Ga}_{1-x}\text{N}/\text{In}_y\text{Ga}_{1-y}\text{N}$ super lattice)/n-GaN layered structure.

20 17. The device according to claim 1, wherein $\text{In}_x\text{Ga}_{1-x}\text{N}/\text{In}_y\text{Ga}_{1-y}\text{N}$ layers of the second electrode contact layer have a thickness of 2-50 Å, respectively and alternately.

25 18. The device according to claim 14, wherein the $\text{In}_x\text{Ga}_{1-x}\text{N}/\text{In}_y\text{Ga}_{1-y}\text{N}$ layers of the second electrode contact layer have a total thickness of less than 200 Å.

30 19. The device according to claim 1, wherein the second electrode contact layer has a doped silicon.

35 20. The device according to claim 1, wherein the n-type nitride semiconductor layer and the In-containing super lattice structure formed above the n-type nitride semiconductor layer is repeatedly formed.

21. The device according to claim 1, wherein the In-containing super lattice structure layer formed of $\text{In}_x\text{Ga}_{1-x}\text{N}/\text{In}_y\text{Ga}_{1-y}\text{N}$ is provided at least one.

5 22. The device according to claim 1, wherein the p-type nitride semiconductor layer is formed to have a multi-layered structure in which a doped amount of magnesium is sequentially increased.

10 23. The device according to claim 2, wherein the second In-containing nitride gallium layer has a chemical formula of $\text{In}_x\text{Ga}_{1-x}\text{N}$ ($0 < x < 0.1$), and has a thickness of 300-2000 Å.

15 24. A nitride semiconductor light emitting device comprising:

 a first electrode contact layer;

 a first cluster layer formed above the first electrode contact layer;

20 a first In-containing nitride gallium layer formed above the first cluster layer;

 a second cluster layer formed above the first In-containing nitride gallium layer;

 an active layer formed above the second cluster layer; and

25 a p-type nitride semiconductor layer formed above the active layer.

30 25. The device according to claim 24, wherein the first and/or second cluster layers are/is formed of SiN_x .

 26. The device according to claim 24, wherein the active layer comprises:

 a first quantum well layer having an $\text{In}_y\text{Ga}_{1-y}\text{N}$ well layer/ $\text{In}_z\text{Ga}_{1-z}\text{N}$ barrier layer structure;

35 a second In-containing nitride gallium layer formed above the first quantum well layer; and

a second quantum well layer formed above the second In-containing nitride gallium layer to have a structure of at least one of $\text{In}_y\text{Ga}_{1-y}\text{N}$ well layer/ $\text{In}_z\text{Ga}_{1-z}\text{N}$ barrier layer.

5 27. The device according to claim 24, further comprising a second electrode contact layer formed above the p-type nitride semiconductor layer.

10 28. The device according to claim 27, wherein the second electrode contact layer has an In-containing super lattice structure.

15 29. The device according to claim 24, further comprising a Si-doped In-containing super lattice structure formed above the p-type nitride semiconductor layer.

30 30. The device according to claim 24, wherein the first electrode contact layer comprises:

an In-doped GaN layer;

20 an $\text{In}_x\text{Ga}_{1-x}\text{N}/\text{In}_y\text{Ga}_{1-y}\text{N}$ super lattice structure layer formed above the In-doped GaN layer; and

a Si-In co-doped GaN layer formed above the $\text{In}_x\text{Ga}_{1-x}\text{N}/\text{In}_y\text{Ga}_{1-y}\text{N}$ super lattice structure layer.

25 31. The device according to claim 24, wherein the active layer has a single quantum well structure or a multi quantum well structure, which has $\text{In}_y\text{Ga}_{1-y}\text{N}$ well layer/ $\text{In}_z\text{Ga}_{1-z}\text{N}$ barrier layer.

30 32. The device according to claim 24, wherein the active layer is comprised of the $\text{In}_y\text{Ga}_{1-y}\text{N}$ well layer and the $\text{In}_z\text{Ga}_{1-z}\text{N}$ barrier layer, and a SiN_x cluster layer interposed therebetween.

35 33. The device according to claim 24, further comprising a SiN_x cluster layer formed between the active

layer and the p-nitride semiconductor layer.

34. A nitride semiconductor light emitting device comprising:

an n-type first electrode contact layer;

5 a first SiN_x cluster layer formed above the first electrode contact layer;

a first In-containing nitride gallium layer formed above the first SiN_x cluster layer;

10 a second SiN_x cluster layer formed above the first In-containing nitride gallium layer;

an active layer formed above the second SiN_x cluster layer, for emitting light;

a p-type nitride gallium layer formed above the active layer; and

15 an n-type second electrode contact layer formed above the p-type nitride gallium layer.

35. A nitride semiconductor light emitting device comprising:

20 an n-type first electrode contact layer;

a strain control layer formed over the first electrode contact layer;

25 an active layer formed over the strain control layer, for emitting light, to have an $\text{In}_y\text{Ga}_{1-y}\text{N}$ well layer, a SiN_x cluster layer having a thickness of atomic scale, and an $\text{In}_z\text{Ga}_{1-z}\text{N}$ barrier layer;

a p-type nitride gallium layer formed above the active layer; and

30 an n-type second electrode contact layer formed above the p-type nitride gallium layer.

36. A nitride semiconductor light emitting device comprising:

an n-type first electrode contact layer;

35 a strain control layer formed over the first electrode contact layer;

an active layer formed above the strain control layer;
a SiN_x cluster layer formed above the active layer;
a p-type nitride semiconductor layer formed above the
 SiN_x cluster layer; and
5 an n-type second electrode contact layer formed above
the p-type nitride semiconductor layer.

37. A nitride semiconductor light emitting device
comprising:

10 an n-type first electrode contact layer;
a strain control layer formed above the first electrode
contact layer;
an active layer formed above the strain control layer
to have a first quantum well layer, a second quantum well
15 layer, and an $\text{In}_x\text{Ga}_{1-x}\text{N}$ layer interposed between the first
quantum well layer and the second quantum well layer;
a p-type nitride semiconductor layer formed above the
active layer; and
an n-type second electrode contact layer formed above
20 the p-type nitride semiconductor layer.

38. A nitride semiconductor light emitting device
comprising:

an n-type first electrode contact layer;
25 an active layer formed above the first electrode
contact layer, for emitting light;
a p-type nitride semiconductor layer formed above the
active layer; and
an n-type second electrode contact layer formed above
30 the p-type nitride semiconductor layer to have an $\text{In}_x\text{Ga}_{1-x}\text{N}/\text{In}_y\text{Ga}_{1-y}\text{N}$ super lattice structure.